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HISTORY AND TECHNOLOGY



# Photography

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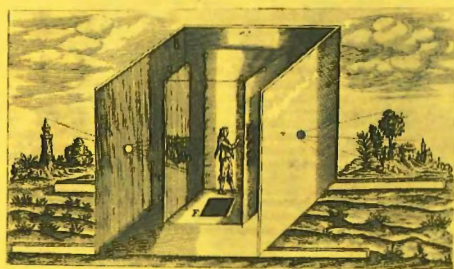


Fig. 1. An artist traced scenery with this 17th-century camera obscura.

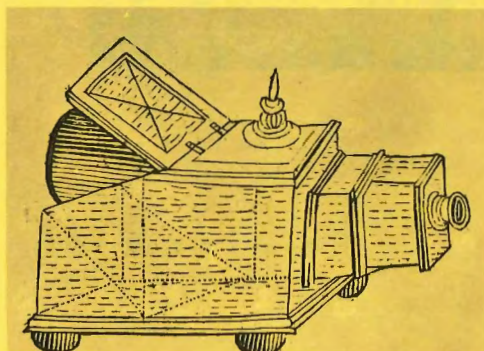


Fig. 2. The miniaturized camera obscura was the basis of the modern reflex photographic camera.



Fig. 3. W. H. F. Talbot used this camera about 1836. Note the peephole through which the image quality of the negative was observed as it gradually "printed out."

Our view of the world today is profoundly influenced by photography—a medium which captures moments of history with unerring accuracy and records remote events permanently for all the world to see. Through photography, we can witness what is happening today—and preserve what took place yesterday. This revolutionary mode of communication has accelerated the pace of life.

Photography has also created new areas of scientific investigation. It permits the study of events which are invisible to the human eye or which occur in areas where the human being cannot exist. It has introduced us to the magnificence of the ocean depths and to the awesome wonder of outer space. Photography has also developed as an art form.

The term *photography* is derived from the Greek language and means "writing with light." Historically, photography results from two separate developments: a method of forming an image in a lighttight container, or camera; and the invention of a chemical coating which, when struck by light, darkens to preserve an image.

The basic design of cameras was established long before photography was introduced. The ability to form images optically by controlling light within a container was demonstrated in the 11th century with camera obscuras (fig. 1). In the 17th century the light response of various chemicals was investigated, and two centuries later camera obscuras were used to produce images on chemical coatings. By then, these devices were small, boxlike, portable arrangements with lenses—the forerunners of modern equipment (fig. 2).

Following the invention of photography, camera shapes and arrangements were modified greatly to conform to the needs of different systems, but basically their purpose remained the same: to provide a light-tight container and enclose the light-sensitive material which receives the image.

#### Light-Sensitive Coatings

The earliest attempt to capture images photographically was reported in 1802 by Thomas Wedgwood of England, who experimented with silver nitrate and silver chloride coatings on paper. Objects, such as insect wings, were placed on these paper supports and exposed to sunlight; the coatings darkened completely except in areas protected by the objects. When later exposed to sunlight, the white areas of the silhouettes also darkened, and the image was obliterated. A method had yet to be devised to preserve the image.

Time was finally brought to a hazy standstill in 1826 by Joseph Nicéphore Niepce of France, who produced the first known camera photograph, which he called a heliograph. Exposures made by Niepce required a full day of sunlight. The photograph was made on a pewter plate which contained a special asphalt varnish. When exposed in the camera, the coating hardened wherever light struck its surface. Unexposed, still-soft areas were removed with an oil of lavender wash. The extremely slow light response of these coatings proved impractical and

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Front cover: A wet-plate darkroom, about the 1860s, as pictured in *A History and Handbook of Photography*, Gaston Tissandier. New York: Scovill Mfg. Co., 1877. (See page 5.)



*Fig. 4. In the "photogenic drawing" of lace (top), the fabric was placed on paper containing light-sensitive coating. Exposure to light produced the "silhouette." The negative was then placed in contact with the same type of coated paper and exposed (contact printed) to light, resulting in a positive print (bottom).*

the process was never widely practiced, although the image was permanent.

In 1839 the pioneers William Henry Fox Talbot of England and Louis Jacques Mandé Daguerre of France introduced their inventions, both of which resulted in long-lasting pictures (fig. 3). Talbot developed a photographic, negative-positive process from which an unlimited number of prints could be made from a single negative, the system widely used today (fig. 4). For his "photogenic drawings," Talbot



Fig. 5. This is probably a daguerreotype photocopy of the original daguerreotype by Professor John W. Draper of his sister, Dorothy Catherine Draper, about 1840.

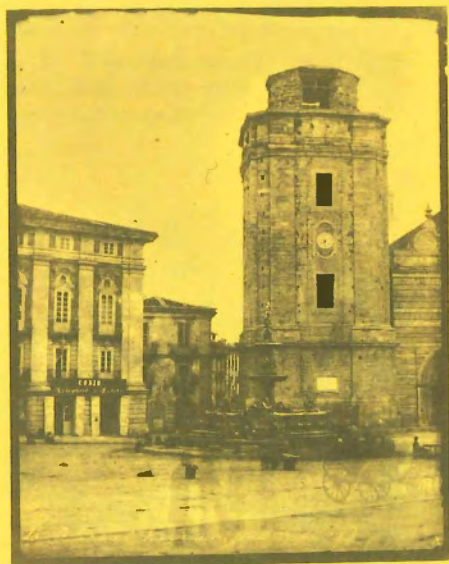


Fig. 6. In this calotype of a European square, about the 1840s, the ghostlike images of people who moved during the long exposure are visible on a wagon.

coated a thin sheet of writing paper with a solution of common (table) salt, followed by one of silver nitrate. Silver chloride was formed, which darkened when exposed to light. The image was made "permanent" by bathing it in a concentrated solution of salt. The positive, or print, was made from this negative by placing it in contact with a sheet of paper that had been treated with a similar light-sensitive coating, and exposed to sunlight.

Daguerreotypes were made on silver-coated copper plates. A light-sensitive surface was created by fuming the silver with iodine, which forms silver iodide. After exposure, the image was developed by fumes from heated mercury; hypo (sodium thiosulfate) served as the fixer which made the image permanent.

Those who posed for the earliest versions of Talbot's and Daguerre's processes had to remain motionless for long periods (fig. 5), and for this reason most of their earliest photographs depicted scenery and still-life subjects. These initial processes were time-consuming, and each photograph required elaborate preparation. For several generations thereafter, photographers had to prepare their own chemical coatings immediately before the picture was taken. But, despite the complexities of these processes, the magical quality of photography proved irresistible; scientists, artists, and dabblers were drawn into its spell.

#### Negative-Positive System

By 1841 Talbot had introduced an improved paper negative-positive system, the calotype, which provided shortened exposure times. At this point, both calotypes and daguerreotypes were so improved chemically that images of live subjects could be captured. Exposures in sunlight were made in a matter of minutes (fig. 6).

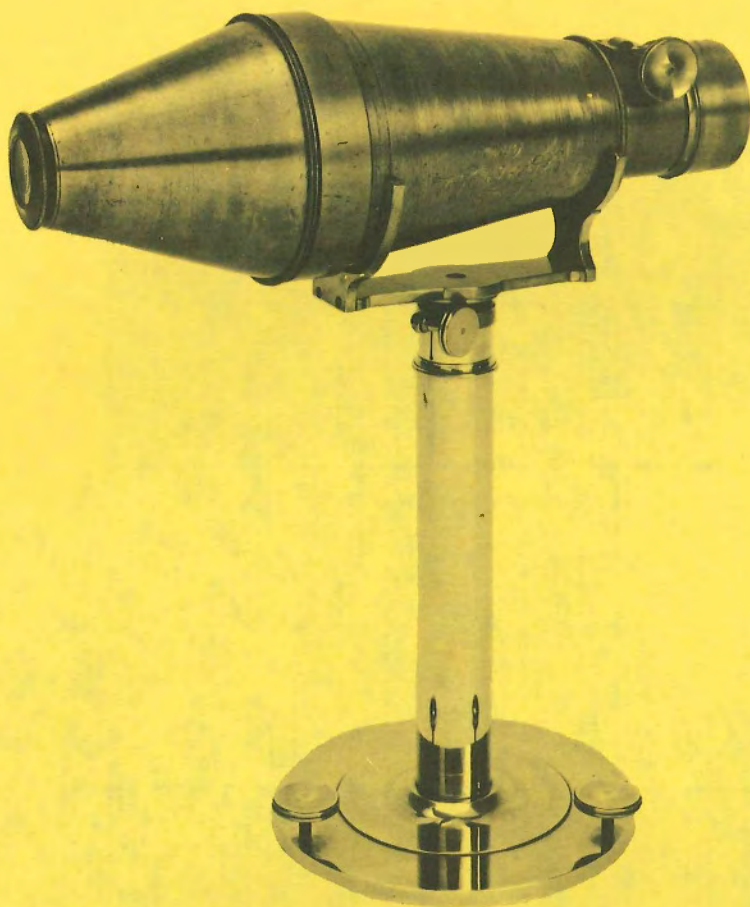
Improved, faster lenses further reduced exposure times by permitting more light to reach the sensitized surface. A major breakthrough in photographic optics was made in 1840 by Josef Petzval, an Austro-Hungarian, who designed the first mathematically computed lens. An  $f/3.5$  portrait lens, it was used in a brass, conical-shaped Voigtlander daguerreotype camera (fig. 7). By 1860 a wide selection of reasonably fast lenses were being used by photographers everywhere.

Although daguerreotype images captured tonal nuances with breathtaking delicacy and outstanding fidelity, they had severe disadvantages. The silvered plates were difficult to view and had to be held at just the right angle to be seen. Each photograph was unique, and additional copies could be obtained only by rephotographing the original scene or by photocopying the original plate. Furthermore, the technique of polishing the silverplated surface, preparatory to applying the sensitizing chemicals, was a meticulous craft (fig. 8).

Even Talbot's practical approach of using a negative to produce an unlimited quantity of prints had drawbacks. The translucent, fibrous characteristics of the paper-supported images interfered with the light that passed through the negative, thus affecting image definition and extending printing time.

#### Collodion Wet Plates

The problems presented by the paper negative were eliminated by the transparent glass-plate negative, which was invented by Sir John



*Fig. 7. Unlike the earliest cameras, whose lenses were too "slow" for portraiture, the Voigtlander daguerreotype camera was the first to incorporate a "fast" lens.*



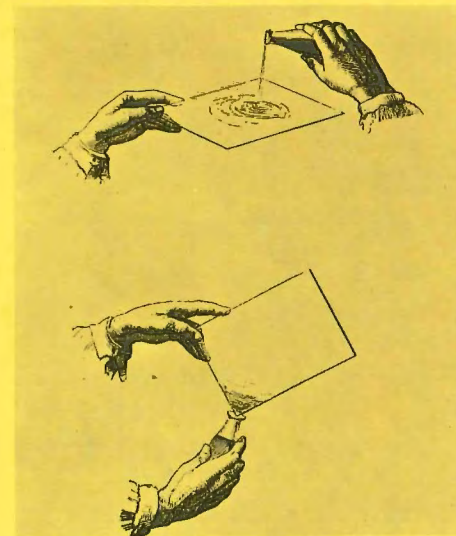
*Fig. 8. Alexander Wolcott received the first U.S. photographic patent on May 8, 1840, for this wooden daguerreotype camera.*



*Fig. 9. Julia Margaret Cameron, one of the first woman photographers, took this portrait of Sir John Herschel in 1866.*

Herschel of England in 1839 (fig. 9). His approach incorporated a silver-chloride coating which, after drying, was covered with a silver-nitrate solution. Unfortunately, the images rubbed off the glass too easily and the process was abandoned. In 1850 another Englishman, Robert Bingham, devised a wet-plate negative coated with collodion (a transparent glue), to which he added ferrous iodide. Prior to exposure, the plate was dipped in a silver-nitrate solution to make it light-sensitive. A year later, Bingham's countryman Frederick Scott Archer introduced an improved version, which provided outstanding, high-quality images requiring less exposure time.

The wet-plate coating technique required practiced timing, nimble fingers, and an experienced wrist motion. In a darkroom, under a yellowish light, the plate was balanced horizontally on the fingertips of one hand; the thick, glue-like collodion was poured onto the center of the plate with the other hand (fig. 10). It was very important to produce a uniform coating; this was done by tilting the plate and rotating it while the surplus solution was drained off. The plate was then quickly dipped in a sensitizing solution, clamped in a plate holder, rushed to the camera, exposed, and rushed back to the darkroom for processing.



*Fig. 10. Iodized collodion is poured onto the glass plate (top), and then the excess solution is drained off (bottom).*



Fig. 12. Along with views of encampments, supply harbors, and battlefields, Roger Fenton captured scenes of soldiers' life. (Courtesy of Library of Congress.)



Fig. 13. This picture of a rebel sharpshooter in Gettysburg, Pennsylvania, in July 1863, was preserved by James Gardener in Gardener's Photographic Sketch Book of the War.

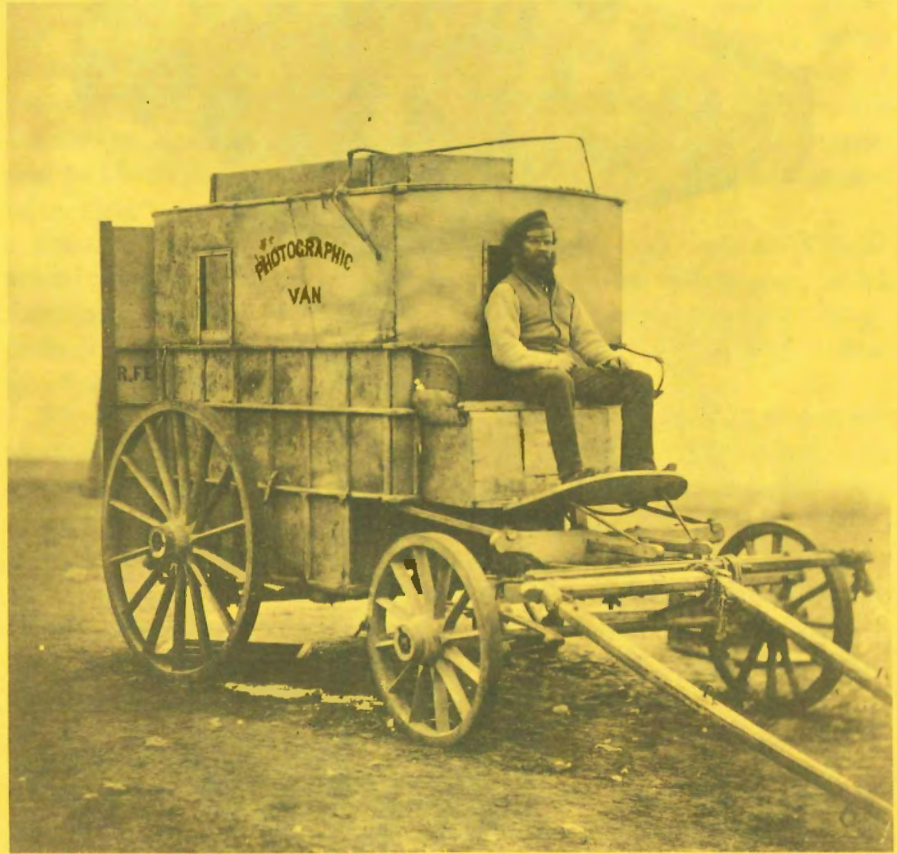


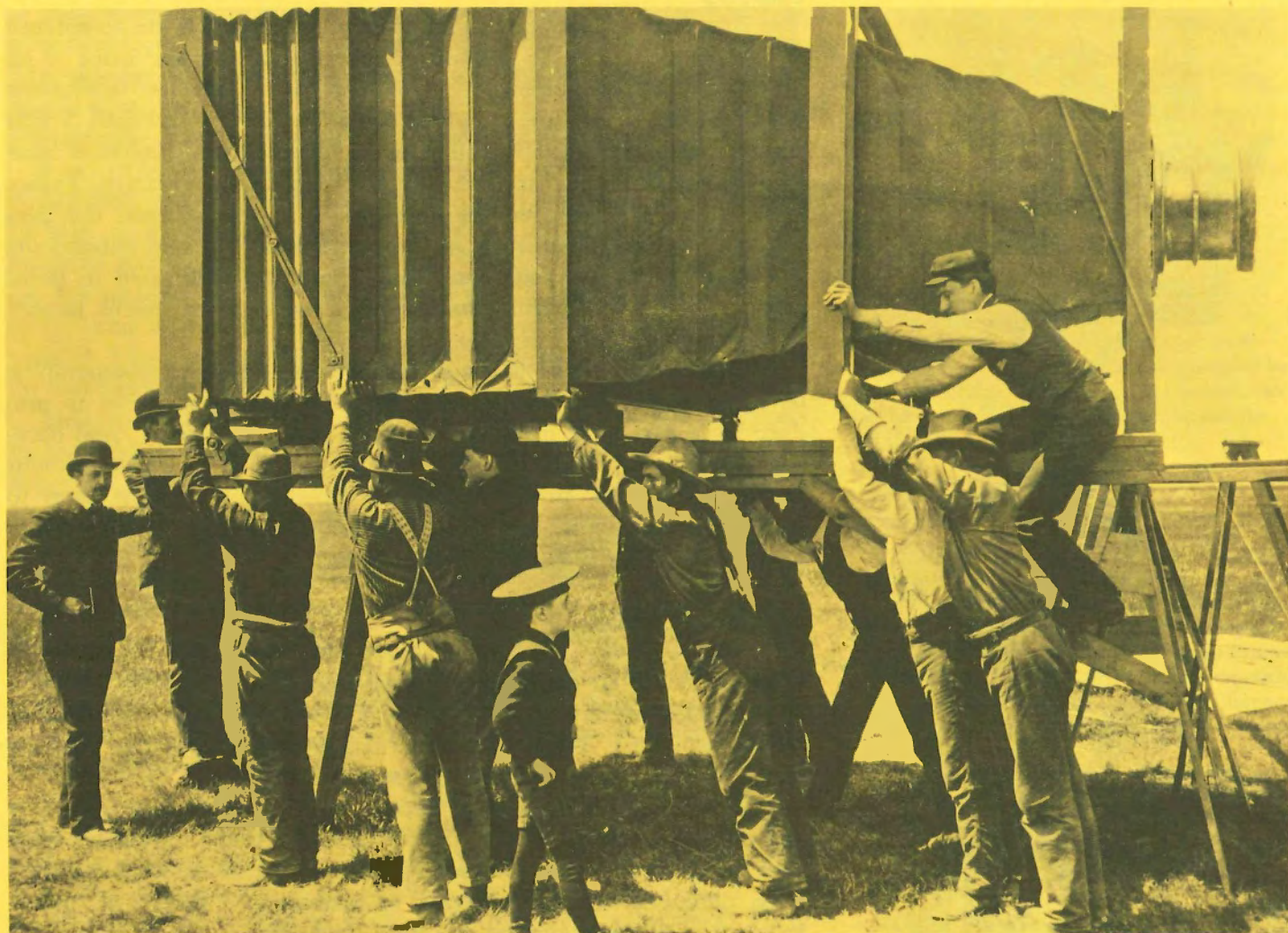
Fig. 11. Marcus Sparling, Roger Fenton's assistant, is shown on the van they traveled in while photographing the Crimean War in 1855. (Courtesy of Library of Congress.)

The darkroom was located close to the camera because the plate had to be exposed and processed while still damp, during its period of maximum sensitivity.

Compared to earlier approaches, Archer's process was relatively simple to manipulate. The responses of these coatings were reasonably sensitive, and they produced very high quality images. This process rapidly captured the imagination of photographers, and collodion wet-plate photography dominated the field for 25 years.

In 1855 an Englishman, Roger Fenton, used the collodion wet-plate process to embark upon the most ambitious photographic project of that decade. He was hired by a publisher to photograph the Crimean War, and thereby became the first professional photojournalist. Fenton overcame severe hardships to produce magnificent photographs of war-time activities. The task was herculean because he brought all of his equipment and supplies—including 14" x 18" plates—from England to the Crimea (figs. 11 & 12).

Fenton photographed encampments, supply harbors, and battlefields, using a horse-drawn van as his darkroom and occasional living quarters. Ten years later, in the United States, numerous photographers pro-



*Fig. 14. George R. Lawrence employed a giant camera in 1901 to photograph a train. The plate measured 4'8"  $\times$  8'. (Courtesy of Chicago Historical Society.)*

duced outstanding documentation of the American Civil War, among them Mathew Brady and his large staff (fig. 13).

Heavy and elaborate photographic equipment was required for the collodion wet-plate process because it was necessary to manufacture and process each plate at the scene, wherever the picture was taken. The mobility and creative techniques of photographers were hampered by these disadvantages, as well as by limitations in varying print sizes.

Before enlargers became available, image sizes were changed by re-photographing the original plate or print; alternatively, large plates were used to photograph the original subject. This latter approach reached a ludicrous proportion with the camera used by George R. Lawrence in 1901 to photograph a train: his plate measured 4'8"  $\times$  8' (fig. 14).

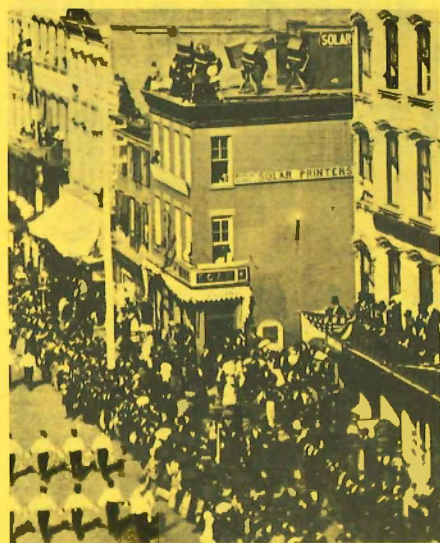
Photographs became more widely available to the public with the introduction of ambrotypes and tintypes, which were inexpensive variations of the collodion wet plate. The image quality of both processes was poorer, but tintypes were printed on thin sheets of tin rather than fragile glass, which made it possible to send them through the mails (fig. 15).



*Fig. 15. Two icemen posed for this tintype.*



*Fig. 16. An American, David A. Woodward of Baltimore, designed a solar camera, or enlarger, about 1880. A condensing lens concentrated light through the negative. Another lens, inside the camera, projected a magnified image of the negative onto enlarging paper attached to an easel.*



*Fig. 17. The earliest enlargers, such as these on the roof of a New York photographic establishment in April 1871, relied on sunlight.*

## Enlargers

The first enlarger apparatus arrangement to achieve wide acceptance was designed in 1864 by Alphonse Liébert of France and came to be known as a "solar camera" (fig. 16). One of the severest limitations governing the perfection of enlargers was the lack of intensely bright artificial illumination. Until the electric light bulb was invented, sunlight served as the primary light source. At that time, enlarging papers were "slow" and required exposures which depended upon the brilliance of sunlight. These solar cameras were usually located out-of-doors but close to the darkroom, and were constantly readjusted to point directly at the ever-shifting sun, using a swivel arrangement located in the base (fig. 17).

Enlargers introduced a completely new approach to photography, both technically and aesthetically. They eliminated the need to produce large glass-plate negatives; cameras, plates, accessories, and dark-room equipment could be made smaller and more portable without restricting the final print size (fig. 18). Smaller plates were easier to coat, easier to handle, and photographers could range further afield, unencumbered by heavy, bulky equipment.

## Dry Gelatin Emulsions

Less than a decade later, in 1871, another Englishman, Richard L. Maddox, made an important contribution to photography: he produced images on glass plates coated with sensitized gelatin, which could be used while dry. The gelatin not only possessed the glue-like property of collodion but also enhanced light-sensitivity.

The dry plates were popular because they retained their sensitivity and could be stored for long periods of time. These advantages soon gave rise to commercially prepared gelatin dry plates, which completely freed photographers from having to manufacture their own plates. Exposed negatives could be processed elsewhere at a later date. This simplification of the photographic process eliminated the need to carry darkrooms into the field and, as a result, the popularity of photography grew.

The transition to gelatin plates was made easier because the same cameras and lenses were used for both the collodion and the gelatin processes. Only the plate holders required a small modification: an arrangement for collecting solution dripped from the wet plates was eliminated.

Another milestone in photography occurred in 1873 when Dr. Hermann W. Vogel, an Austrian, discovered that certain dyes, when added to photographic coatings, make them react to colors other than blue. Previously, photographic coatings recorded only blue portions of the spectrum reflected by the subject. For example, the red of lips appeared on the negative as if it were black.

Subjects were recorded with greater fidelity with these dye additives. They also responded more quickly to light, and exposures were shortened. Vogel's contribution helped make color photography possible.

## Roll Film

Fifteen years later, in the 1880s, transparent, flexible film created a completely new and popular interest in photography. This material,

in spool-wound form, provided a great many exposures which could be stored compactly. As a result, cameras were reduced in size and weight. The expense, inconveniences, and dangers of handling and processing fragile glass plates were finally eliminated. New, creative approaches to photography were made possible through this innovation (fig. 19).

A patent application for a gelatin emulsion coated on a transparent, flexible roll film was filed in 1887 by Hannibal Goodwin of New Jersey. In 1888 the Eastman Dry Plate and Film Company introduced an easily operated spool-film camera, the Kodak, which cost \$25, including film for 100 pictures (fig. 20). For a charge of \$10, the user returned the entire camera to the factory, where the exposed film was processed and printed. The mounted prints and the camera, reloaded with fresh film for another 100 exposures, were sent back to the customer.

This system revolutionized photography. The user needed absolutely no knowledge of manufacturing, handling, and processing photographic materials. George Eastman's advertising slogan, "You press the button, we do the rest," was true to its claim.

The introduction of roll film was rapidly followed by accessories which permitted the processing to be done outside of darkrooms. Exposed film was darkroom-loaded into a lighttight solution container which then could be handled in normal room light. Solutions were poured through a special light trap, and film agitation was accomplished by externally manipulated spindles. This encouraged interest in a do-it-yourself approach by photographic hobbyists which has continued to the present day.

In the early 1900s electric light became generally available, and the light bulb was soon incorporated into compact enlargers which were installed in darkrooms. New enlarging papers were manufactured that responded more rapidly to the artificial light sources in enlargers. Film speed and image definition were constantly being improved. These technological advantages provided the foundation for the highly versatile, creative arrangements being used in the field today.

Reductions in the size and weight of photographic equipment were also made possible by the constant refinement of lenses, which were made "faster"—permitting more light to reach the negative—and capable of fewer optical distortions.



Fig. 18. The compact collodion, 4" X 5" wet-plate outfit, about 1869, manufactured by Frederick Cox, London optician, included all of the equipment and chemicals needed for making negatives.



Fig. 19. Flexible roll film was lightweight, compact, and unbreakable. Twelve exposures on film weighed less than a single glass plate.

Fig. 20. Introduced in 1888 by Eastman Dry Plate and Film Company, the first Kodak camera cost \$25, including film for 100 pictures. In 1899 Eastman marketed the transparent roll film (far right).

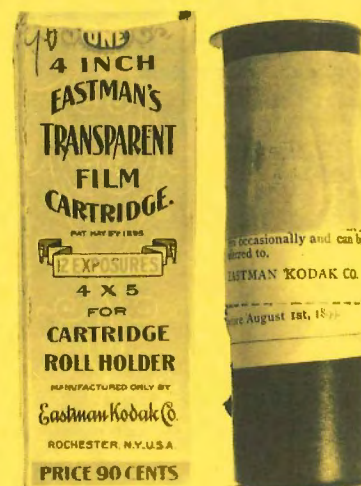




Fig. 21. Ermanox cameras of this type (1924) were popular with 20th-century pioneering photojournalists, such as Erich Salomon, when lighting was poor. They had a "fast" lens (f2) and used small plates.

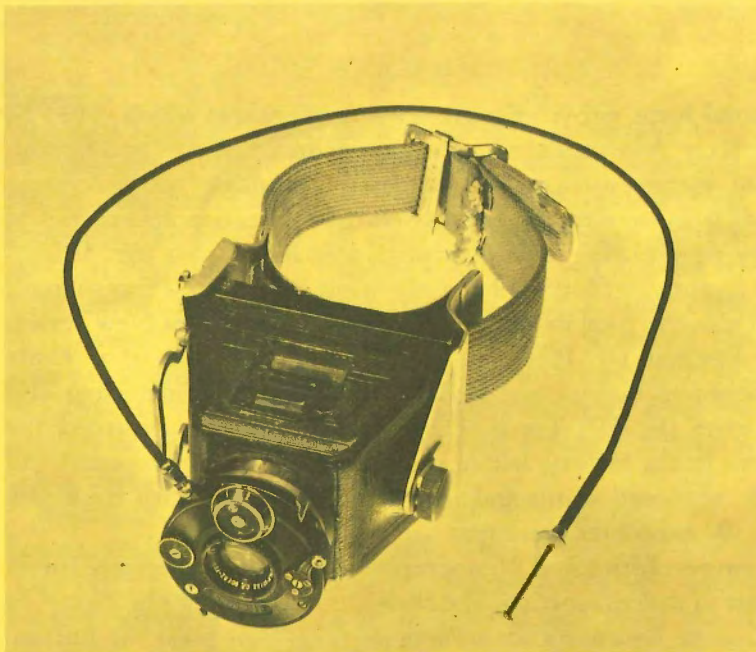


Fig. 22. Designed to photograph the 1928 execution of Ruth Snyder, who killed her husband, this camera contained only one plate and was strapped to the ankle of New York Daily News reporter Tom Howard, who smuggled it into the Sing Sing Prison execution chamber. A cable release ran into his pocket; a long time exposure was used.



Fig. 23. Made in the 1930s, this camera was camouflaged in a cigarette pack.

### Microphotography

With the improvement of sensitized materials and equipment, microphotography—the making of very small negatives—developed a wide range of applications. Today microphotographic systems form a vital instrument of commerce, industry, research, and education. They are used in reducing the bulk of documents and publications; in rapid-access information systems; and in producing electronic components.

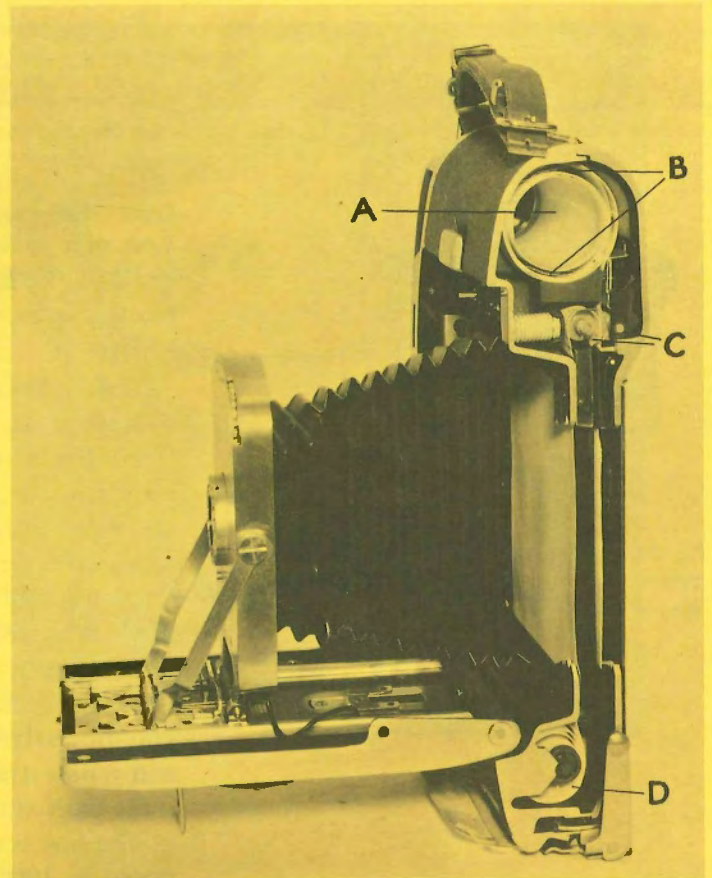
The interest in shrinking photographic image size started almost with the birth of photography. In 1839 John Benjamin Dancer of England produced a  $\frac{1}{8}$ -inch-long daguerreotype image of a document measuring 20 inches. By 1853 Dancer produced extremely small photographs on microscope slides containing sensitized collodion. When Paris was surrounded during the Franco-Prussian War in 1870, a Frenchman, Prudent René Patrice Dagron, produced microphotographic messages which were flown by carrier pigeons from the French battlelines into the city. In eight weeks, more than 2,500,000 messages were sent.

Microphotographic technology was refined during World War II by German espionage agents who succeeded in photographically reducing messages on discs of film which could be hidden within the paper fibers of periods in typewritten notes. The start of a very practical commercial use of microphotography was introduced by George McCarthy, who devised a system of microfilming bank checks to minimize the problems of loss and fraud. This system, the Checkograph, was perfected and marketed in 1926 by Kodak.



Fig. 24. Another camera designed by the New York Daily News fitted into the heel of a shoe.

Fig. 25. The cutaway view of the Polaroid Land Camera, Model 150 (1957), shows (a) receptacle for positive paper; (b) placement of pods of processing solution; (c) steel rollers; and (d) receptacle for negative paper.



The continuous improvement of emulsions and lenses has led to the design of a large variety of equipment for microphotographic application. In addition to the practical, commercial uses which rely on very small negative sizes, manufacturers introduced subminiature novelty cameras in the form of wristwatches, cigarette lighters, and ladies' compacts. Variations of these devices were used for surveillance and espionage work. Starting in the 1920s, news photographers and photo-journalists abandoned their 5" x 7" and 4" x 5" Graphlex and Speed Graphic cameras and began to adopt small-format roll film for their assignments (fig. 21). The expanded possibilities of capturing newsworthy events prompted the photography-conscious *New York Daily News* to design its own equipment for "scooping" its competitors (figs. 22, 23 & 24).

#### Instant Prints

In the late 1940s Edwin Land developed a technique which enabled photographers to produce finished prints within seconds without using a darkroom (fig. 25). Among the unique features of Land's Polaroid camera is a processing system incorporated within the roll of sensitized material. Simultaneously, after exposure, the film and specially coated paper are brought together between a pair of steel rollers, and a pod of thick processing solution is broken and spread evenly between the materials, producing the print. The processing time for black-and-white prints has been reduced to 10 seconds; that for finished color prints requires only minutes.

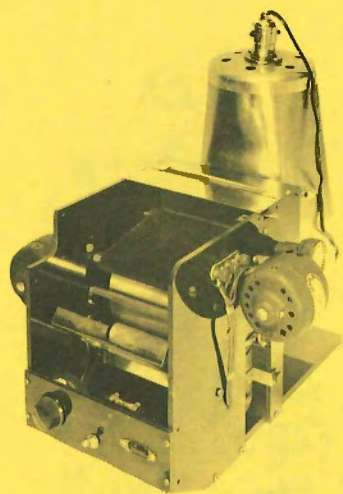


Fig. 26. A forerunner of today's Xerox copy system, this model was built by its inventor, Chester Carlson.

Photography has also branched out into rapid-copy systems for document duplication. One such is the Xerox system, whose inventor, Chester Carlson, produced his first permanent image in October, 1938 (fig. 26).

### Color Photography

Less than two decades after Talbot and Daguerre made photography feasible, the English scientist James Clerk Maxwell, in 1857, suggested photographic color reproduction and, in 1861, produced the first color picture.

Maxwell made three "color-separation" negatives of his subject—one through a red, another through a green, and the third through a blue filter. From these negatives, black and white positive transparencies were made and recombined into color by projecting them simultaneously onto a screen, each through its respective filter.

A year later, French inventor Louis Ducos du Hauron proposed the same technique of tricolor analysis, or breakdown, with a different method of color synthesis. His work was not published until 1869, when Charles Cros, who had been working independently, also publicized the same theory. It relies upon red, green, and blue photographic analyses of the scene, which are used to produce cyan, magenta, and yellow-dyed components to form the final color image. This method is the basis of nearly all modern color techniques.

The first commercially successful color photographic plate was introduced in 1906 by the French firm of Lumière. Small starch particles dyed blue, green, and red were coated on a glass plate in a single layer. This was varnished and then coated with a black and white emulsion. Exposure was made through the back of the plate and the image was reversal-processed (to yield a positive rather than a negative), and resulted in a full color positive.

Most modern photographic color processes are based upon a multi-layer emulsion structure, described in 1905 by the Austrian K. Schinzel. Known as the integral tripack or monopack, it contains three photosensitive emulsions, each responding to a separate color, on a single support.

In 1912 the German chemists Rudolph Fischer and H. Siegrist helped to establish the intricate chemistry of color couplers which was to serve as the basis of modern color photographic materials.

Various problems of diffusion of the color couplers remained unsolved until the perfection of the Kodachrome process, which placed the yellow-, magenta- and cyan-forming couplers in three separate developer solutions and not in the emulsion layers themselves. In 1935 the Eastman Kodak Company introduced Kodachrome amateur cine film, the first practical color film utilizing color-coupling development. It was based on the work of Leo Mannes and Leo Godowsky and their Kodak associates.

This material was just one of a large range of color materials subsequently introduced which found popularity among amateurs, professionals, and specialized consumers. Various systems were offered, including direct positive and negative-positive films and negative-positive and reversal printing papers. New and modified technology was con-



Fig. 27. Johann Zahn depicted a magic-lantern demonstration in his *Oculus Artificialus, Part III*, in 1702.

stantly introduced to improve color balance, image definition, and speed.

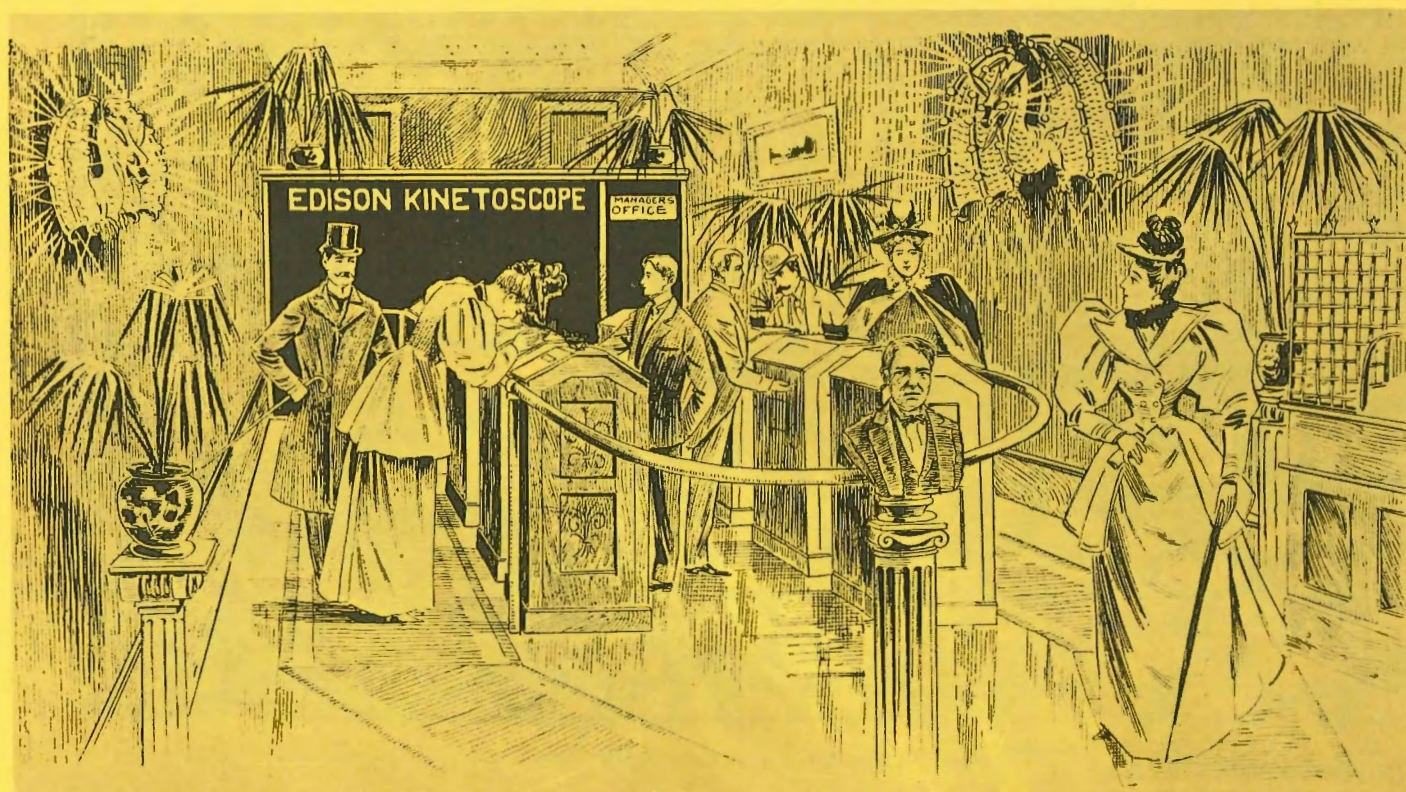
In 1963 the Polaroid Corporation marketed their Polacolor film. This process relies upon chemical properties not previously used in color photography. In a separate layer underneath each of the three emulsions is a special developer-dye compound that functions to develop the exposed emulsion with which it is associated when an activating solution is applied to form the image.

### Moving Pictures

The interest in creating moving images existed long before photography was invented. As early as the 11th century, shadow plays were delighting audiences in the Far East. In 17th-century Europe images were painted on glass and projected onto walls by means of devices called magic lanterns (fig. 27).

"Movement" was introduced later by projecting panoramic slide images and slowly moving them past the lens. This approach was followed by more elaborate arrangements incorporating a "sandwich" of two or more sections of a scene, each of which was moved separately, such as the view of a ship being tossed on a turbulent sea. Other slides relied upon mechanical devices for rotating overlapping slide components to produce kaleidoscopic effects. The maltese-cross gear, which gives the intermittent motion to motion-picture devices, evolved from the magic-lantern slide.

Starting in 1890 various motion-picture cameras and projectors were invented in the United States, England, and France within a short time



*Fig. 28. The Edison Kinetoscope parlor was a popular diversion in the mid-1890s.*

of each other. An American, William Kennedy-Laurie Dickson, a Thomas A. Edison employee, devised in 1890 the Kinetograph camera, which produced motion-picture images and, a year later, the Kinetoscope, an enclosed "peep-show" viewer, which accommodated 50 feet of Kinetograph film (fig. 28). The arrangement was not introduced to the public by Edison until 1894.

The commercially successful Lumière Cinématographe was a versatile system which performed the functions of camera, printer, and projector. It was patented in February, 1895, by Louis Jean Lumière and August Marie Louis Nicholas Lumière, and demonstrated to the Parisian public in December. By this time, showings were expanded to 1,000 feet and were used as vaudeville show "fillers" consisting of several short subjects. Before the turn of the century, stories on film were being made.

By 1912 technology had improved greatly in the United States and, supported by a growing public interest, the movie industry established itself in Hollywood, California, where the climate permitted production year-round.

Earlier in the century, attempts to synchronize phonograph records with film action failed to win popularity. Printed titles were introduced in 1907. Sound with film was finally achieved in 1927 with the Vitaphone showing of "The Jazz Singer," featuring Al Jolson. Since then,

audiences have been exposed to the high quality of the Technicolor process, multiple-sound tracks, wide and full 360-degree screens, three-dimensional images, odors to synchronize with screen action, and vibrating theater seats to coordinate with earthquake scenes.

Black and white and color photographic images are a fundamental part of our lives. They have stimulated hobbies and created new industries. We collect them as postcards, paste them in photo albums, hang them on our walls, and enshrine them in museums. They are used in photomechanical reproduction, such as in this booklet; in printed circuits; and as the basis of high-speed, mass, visual communication. The public now assumes that it will be brought to news-making events through photography.

Photography has also been valuable as a way of authenticating information, such as documenting a crime or a sporting event. Wireless transmission of images, as in television, the added realism of color, and the instant images of Polaroid Land materials have given photography a relevancy that is now essential to our lifestyle. As a medium of creative expression, photography provides us, too, with a new, exciting way to perceive the reality around us.

#### Further Reading

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E. Forbes's drawing of a sitting for a tintype portrait, 1873.